

Climate Change & Insurance: What Regulators Need to Know



Presented to the
International Association of Insurance Supervisors
Ft. Lauderdale, Florida
October 18, 2007

Evan Mills, Ph.D.
Staff Scientist
University of California
U.S. Department of Energy
Lawrence Berkeley National Laboratory

Pre-meeting version

Our atmosphere is as thin — in proportion to the Earth's diameter — as a film of condensation on a small steel ball.



**Climate Change is about Risk
Management,
But the Dice are Loaded**



**State of the Science:
Fingerprints**

The Scientific Consensus
<http://www.ipcc.ch>

Intergovernmental Panel
on Climate Change
TAR - 1300 Authors;
1100 Reviewers
Unanimously adopted by 100+
nations (including U.S.)



Caribbean: Coral Die-Off



Tanzania: Drought > Blackouts



Greenland: Loss of Sea Ice



Iceland: Retreating Glaciers



California: Beetle Super-infestation; Wildfire

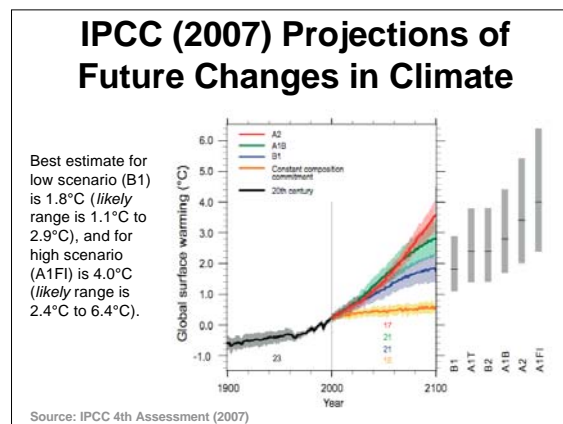
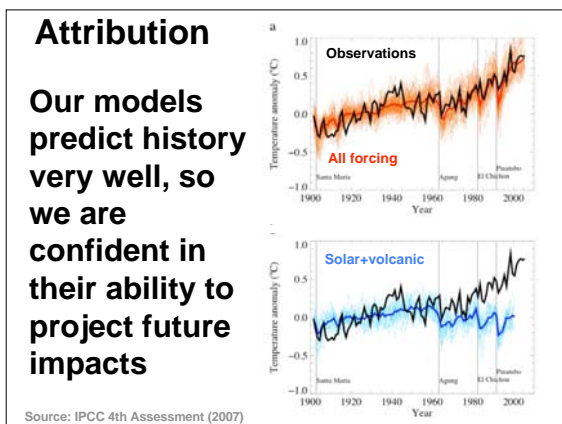
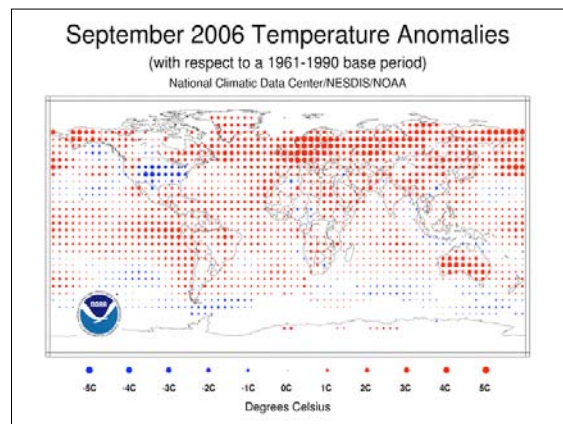
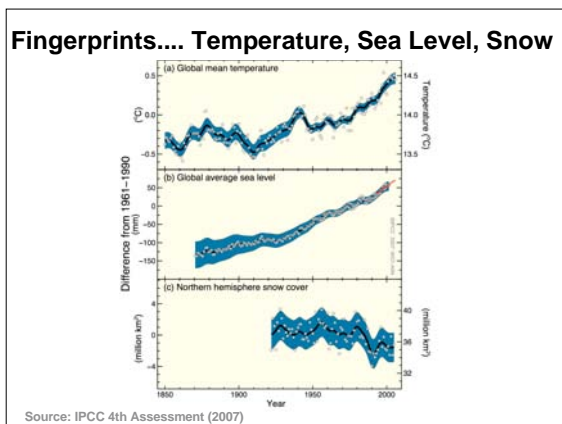
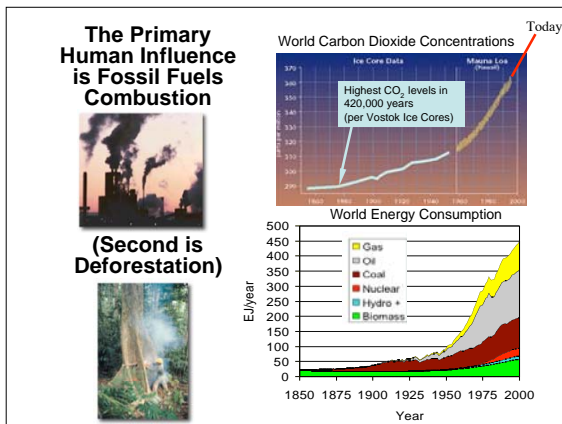


IPCC's Latest Characterization of Climate Change

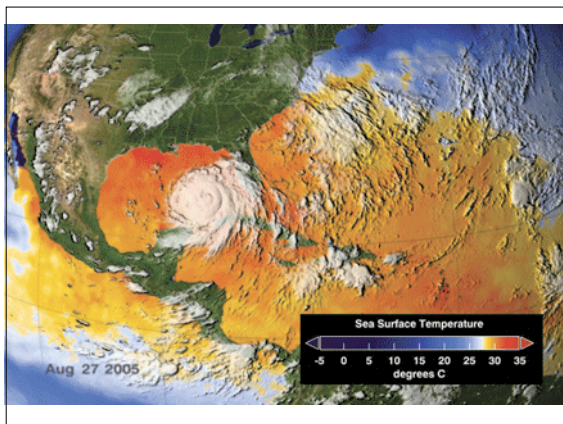
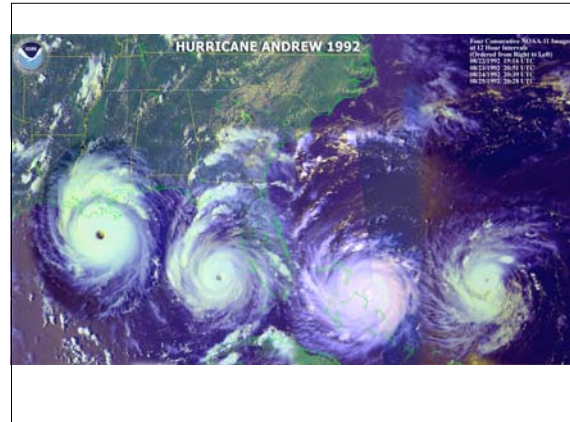
“Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level.”

- IPCC Fourth Assessment Report (2007)

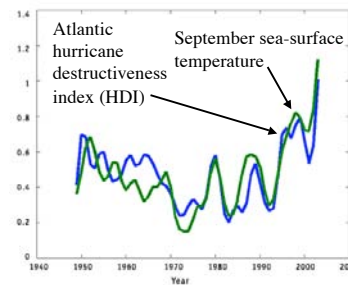
<http://www.ipcc.ch>



Fingerprints



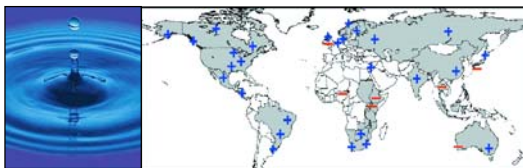
Hurricane Destructiveness Rising



- Hurricane destructiveness increasing in lockstep with ocean temperatures
- 2005 broke all records
 - Number
 - Physical size
 - Storm duration
 - Season duration
 - Southernmost landfall

Source: Kerry Emanuel, MIT (former “climate skeptic”)

Fingerprints.... Torrential Rain



Regions of observed disproportionate changes in heavy (95th %-ile) and very heavy (99th %-ile) precipitation

Source: IPCC 4th Assessment (2007)

Fingerprints.... Floods

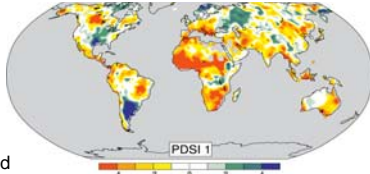
Major floods per decade, 1950-2000



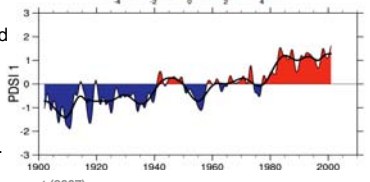
There's a consistent 50-year upward trend in every region except Oceania.

Fingerprints.... Drought

Change in Palmer Drought Severity Index (PDSI) for 1900 to 2002

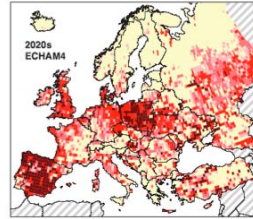


Proportion of land area in extreme drought predicted to increase from 1-3% to 30% by 2090s. Duration expected to increase six-fold.



Source: IPCC 4th Assessment (2007)

Change in Recurrence of 100-year Droughts



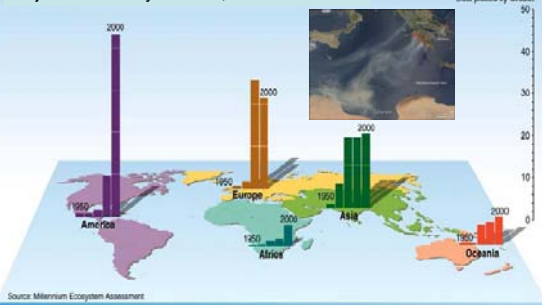
Future return period [years] of droughts with an intensity of today's 100-year events:
 less frequent no change more frequent
 < 100 70 40 10 >

Figure 3.6. Change in the recurrence of 100-year droughts, based on comparisons between climate and water use in 1961 to 1990 and simulations for the 2020s and 2070s based on the ECHAM4 and HadCM3 GCMs, the 1990s emissions scenario and a business-as-usual water-use scenario. Values calculated with the model WaterGAP 2.1 (Lehner et al., 2006).

Source: IPCC 4th Assessment (2007), Ch 3

Fingerprints.... Wildfire

Major wildfires by decade, 1950-2000



Source: Millennium Ecosystem Assessment

The trend has been sharply upward everywhere; CO2 feedback is significant

Fingerprints: Loss of Ice & Snow Cover Loss of 1 million sq. miles by 2007 = 10x U.K.

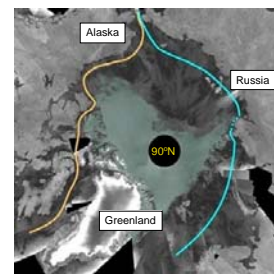


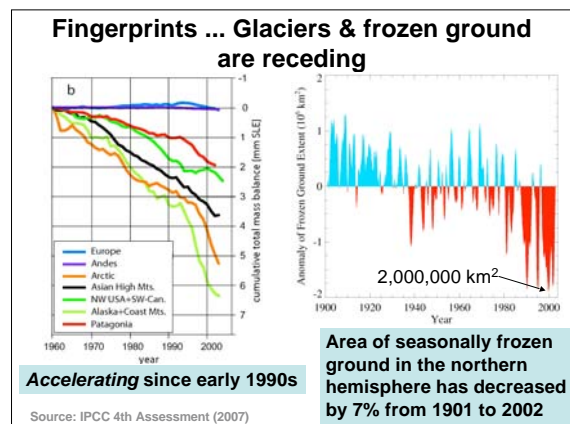
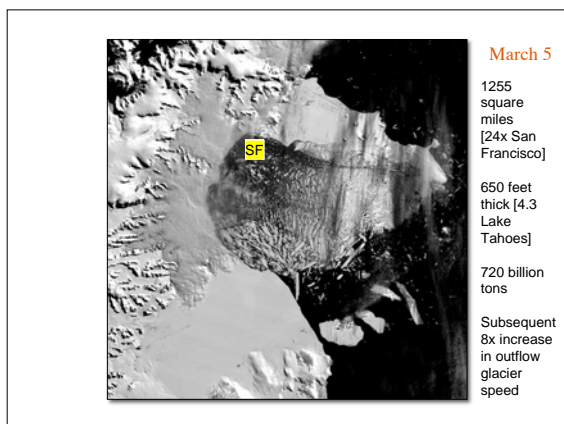
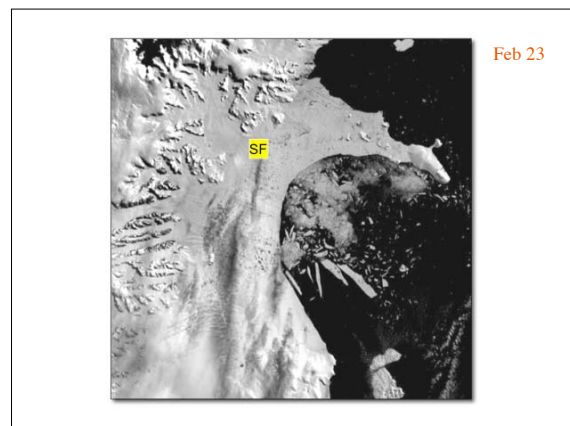
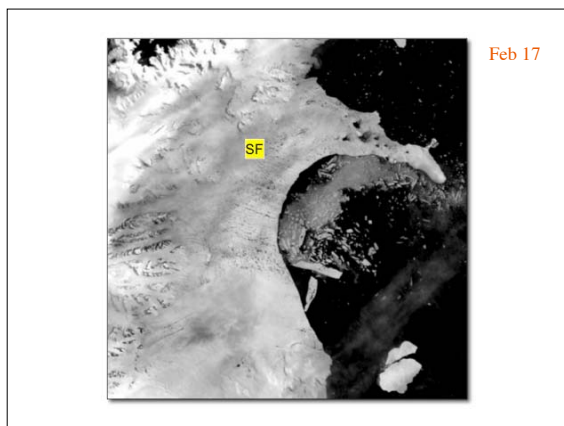
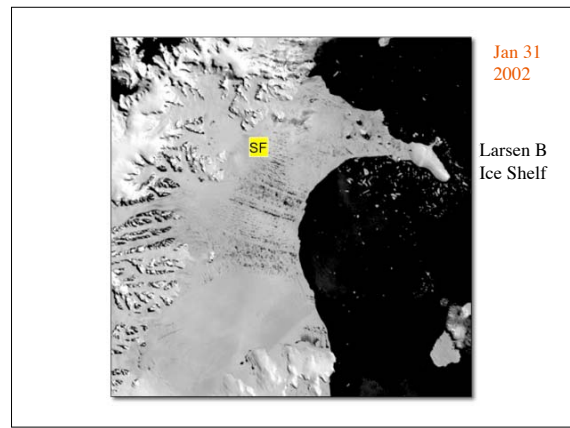
Harvard Expedition to North Pole ... free water



Source: James McCarthy, Harvard

The Northwest Passage is Open





Disappearing Glaciers

1941



2004



Muir Glacier, photographed by William O. Field on 13 August 1941 (left) and by Bruce F. Molnia on 31 August 2004 (right). During this period, the glacier retreated more than twelve kilometers (seven miles) and thinned by more than 800 meters (875 yards).

Source: National Snow and Ice Data Center

Sea-level Rise = 10 feet = half of Greenland melting



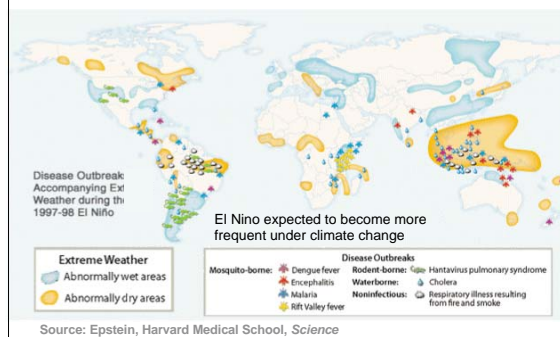
(Source: Harvard University)

Sea-level Rise = 10 feet = half of Greenland melting



(Source: Harvard University)

Correlation of Disease Clusters with the 1997-1998 El Niño Weather Extremes



Overwhelming Correlations IPCC Synthesis of Scientific Literature on Observed Changes 1970-2004

577 studies reviewed



- 765 observed **physical** changes (94% consistent with warming)



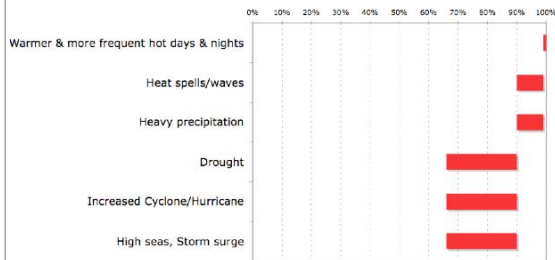
- 28,671 observed **biological** changes (90% consistent with warming)

Source: IPCC 4th Assessment (2007)

The Consensus

- **Human-induced climate change is here:** we've been studying this for over a century
- The climate consensus, is about as good as it ever gets in science.
 - It's about like that for human evolution or the health consequences of tobacco smoke
- One can quibble with specific points, but not with the systematic observed pattern of evidence
- Uncertainties are explicit; and are shrinking
- Unaccounted factors are likely to eventually reveal an even worse problem
- No alternate theory has been advanced

IPCC (2007) Consensus on Future Extremes Events



Source: IPCC 4th Assessment (2007)

Impacts of Future Events @ 3-5°C warming (IPCC 2007)

Water	<ul style="list-style-type: none"> Decreasing availability 100's of millions of people exposed to increased stress
Ecosystems	<ul style="list-style-type: none"> Significant extinctions Widespread coral mortality Change in species range
Food	<ul style="list-style-type: none"> Impacts on subsistence farmers and fishing Decreased productivity of cereal crops
Coasts	<ul style="list-style-type: none"> Millions more people experience coastal flooding ~30% of coastal wetlands lost
Health	<ul style="list-style-type: none"> Increased malnutrition, diarrhoeal, cardio-respiratory, and infectious disease Rising morbidity & mortality: heat waves, flood, droughts Changed disease distributions Substantial burden on health services

Source: IPCC 4th Assessment (2007)

Open Questions

- Not the existence of human-induced climate change, or lack thereof, but rather:
 - How much?
 - How fast?
 - Smooth versus abrupt change
 - Feedbacks
 - Positive
 - Negative
 - Geography of impacts; downscaling
 - Gaps in models (especially cryosphere)
 - Attribution of *Impacts*
 - Society's ability to adapt
 - Costs of mitigation and adaptation
 - Policy pathways

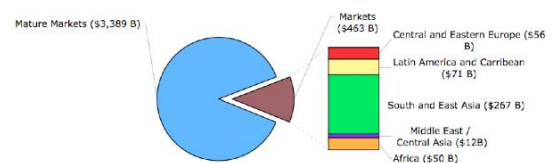
Donuts Exist Despite the Holes



Source: Krispy Creme

Risks for Insurers

World Insurance Market \$4 Trillion in 2006



Source: Swiss Re, Sigma; NAIC

“We'd be out of our minds if we wrote weather insurance on the opinion global warming would have no effect at all.”

- Warren Buffett
2006 annual Shareholder meeting

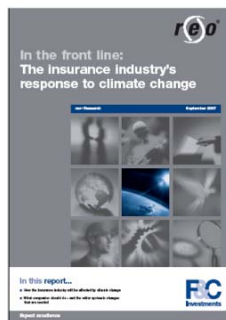
CEA Report: July 2007

- CEA is trade association of 33 European insurance associations, representing 94% of premiums in region
- Strong concern about climate change, and need for proactive steps



F&C Investments Statement: September 2007

- F&C is asset manager with \$200 billion under management.
- Concerned about climate-sensitivity of their investments in insurers.



Insurance Regulators (via NAIC Taskforce) Recognize the Problem

“Global warming is upon us, and it poses unprecedented new threats to the insurance industry and vast segments of society that rely on insurance for peace of mind and financial security.”

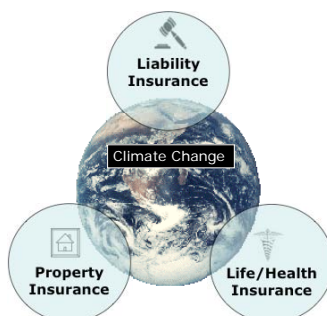
Michael Kreidler
Washington Insurance Commissioner

Tim Wagner
Nebraska Insurance Commissioner

Climate Change: Intersection with Insurance

Insurers are....

- integrators
- risk assessors
- risk managers
- adaptive capacity
- vulnerable
- selective
- potential part of solution



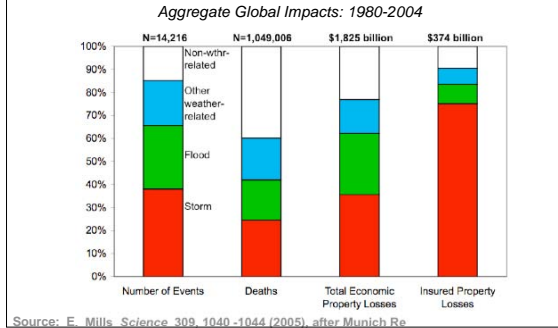
Anticipated Losses

Property	Life/Health	Liability
<ul style="list-style-type: none"> • Property damage • Mold/moisture • Forest products • Agricultural losses • Fisheries • Business interruption • Roadway 	<ul style="list-style-type: none"> • Injury • Infectious diseases • Heat stress • Respiratory • Pollutant releases • Food poisoning • Mental health • Nutrition/water 	<ul style="list-style-type: none"> • Products • Negligence • Nuisance • Fiduciary • Tort / BI • Environmental • Roadway liability insurance

Also in play....

- Surplus lines
- Residual Markets
- Self insurers (captives, RRGs, etc)
- Insurance alternatives (e.g. Takaful)
- ART (alternative risk transfer)
- **and**... public-sector insurance programs (flood, crop, ...)

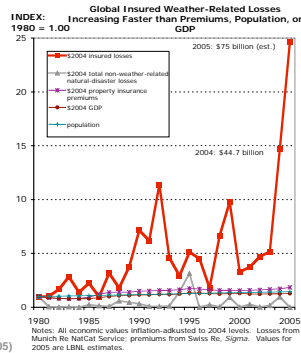
Disasters Look Different Through an Insurance “Lens”



Uncertainty: Physical → Financial

Non-climate factors play a role, but...

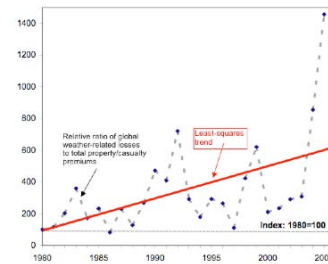
- Trends *consistent* with observed change
- Why are non-weather losses growing more slowly?
- Would have been even worse without prevention efforts



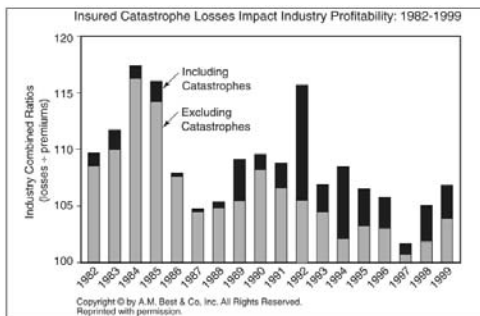
Source: E. Mills Science 309, 1040-1044 (2005)

Risk is OK; Excessive Volatility is Not

The ratio of losses to premium revenues is increasing

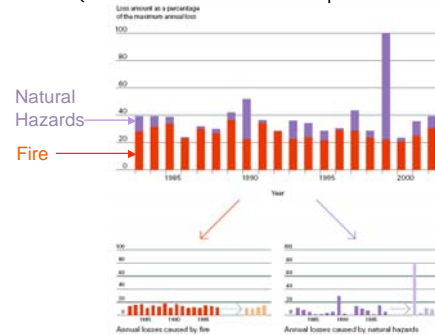


CATs Profoundly Influence Profitability

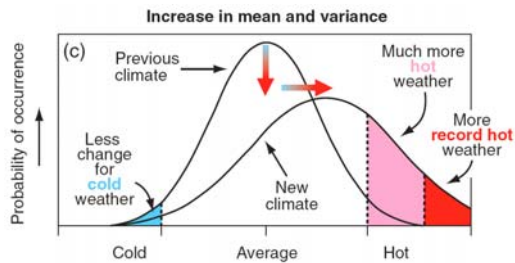


Insured Losses from Natural Hazards Are Less Predictable than Conventional Losses

(% of total in Central Europe: 1983-2002)

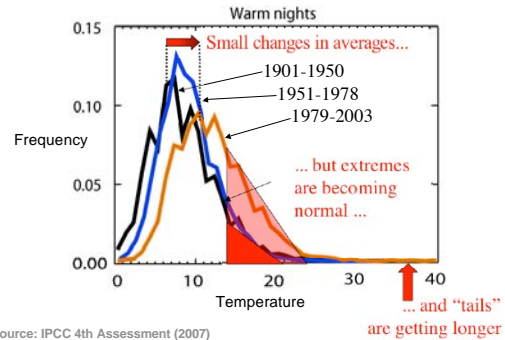


Changes in Extremes



Source: IPCC, Third Assessment Report

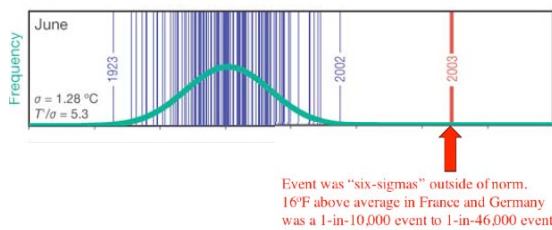
Extremes Shift *More* Than Avg's.



Source: IPCC 4th Assessment (2007)

Rare Extremes Cause Most of the Damages & Insured Losses

The European heat wave of Summer 2003



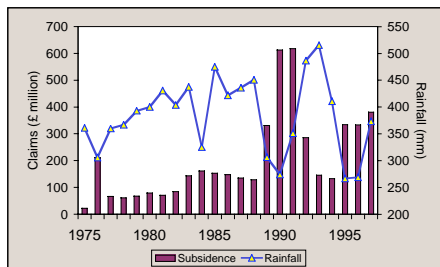
Source: Schar et al, *Nature*, v. 427, 2004.

Small-scale and Indirect Events & Consequences Often Overlooked



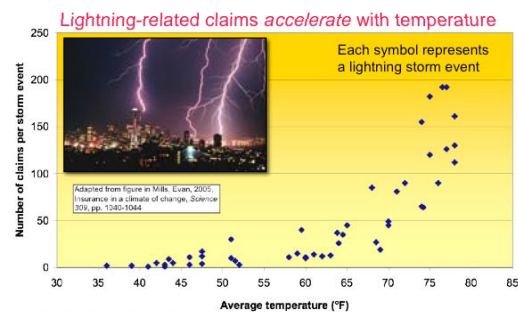
Temperature-Related Insurance Loss Experience

Subsidence claims increase with drought: UK 1975-1999

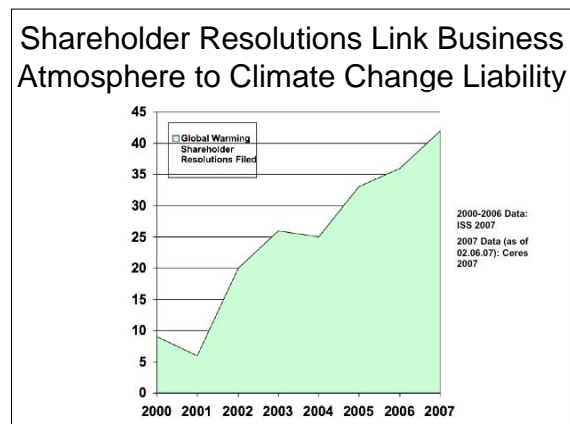
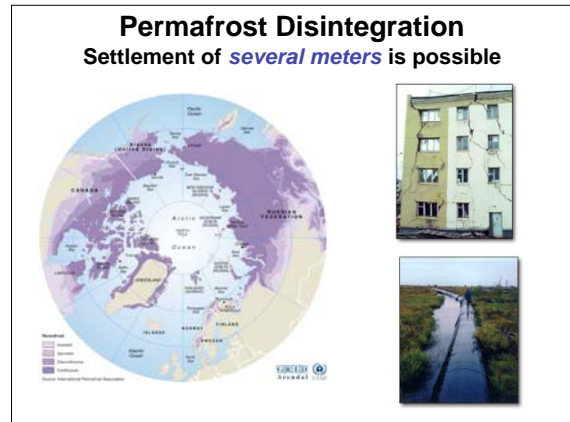
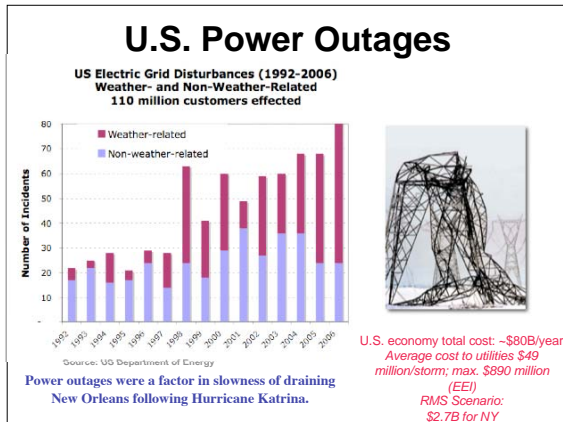


Source: Association of British Insurers

Temperature-Related Insurance Loss Experience



Source: Hartford Steam Boiler Inspection and Insurance Co.





Challenges to the Standards of Insurability

"Radical changes in natural catastrophe frequency and/or severity could eliminate certain of our markets through physical damage, price escalation, or regulatory activity. ... [U]npredictability could negate the use of actuarial techniques and undermine our ability to price and risk-manage product offerings." - ACE Limited (2007)

- Risks measurable, costs predictable, affordable
- Risks diversified, e.g. geographically
- Correlations understood
- Maximum losses manageable (not jeopardizing insurer solvency)
- Adverse selection (purchase of insurance only by those most at-risk) and moral hazard (complacency due to presence of insurance) must be managed

Availability & Affordability

- Exodus of insurers from coasts (*and* elsewhere)
- Quiet "hollowing out" of insurance
- Customers "going Bare": 9 utilities (10% of membership) left in OIL Mutual Ins. Co. May 2007
 - Paid \$100 million in fees to leave
 - CEO says "It was a stunning blow"
- RAND Report on commercial insurance in FL
 - In 2005: one insured paid \$250k for \$38m coverage
 - In 2006: paid \$940k for \$5m coverage, i.e. a ~29-fold bump in the "cost of risk"

Summary: Reasons for Concern

- Underwriting
- Models
- Claims-handling
- Capital
- Operations
- Investments
- Competition
- Contraction
- Shareholders
- Reputation
- Regulation
- Liability
- *Insurability*

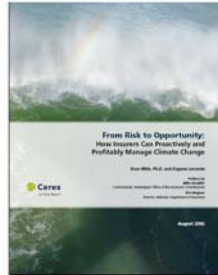
Managing Risks & Capturing Opportunities

From Risk ... to Opportunity

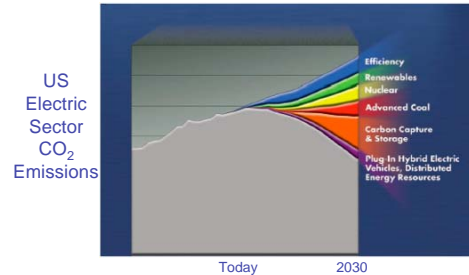
The insurance sector has a key role to play in **helping to mitigate the effects of climate change ... and by developing new products and solutions that can support emerging greenhouse-gas and renewable energy markets.**

- Marsh & McLennan

Ceres Report: 24 strategies;
~310 examples; ~160 insurers



Cutting U.S. Emissions in Half with Climate-Stabalization “Wedges”

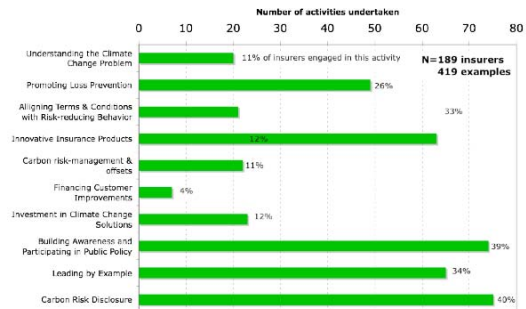


Source: Electric Power Research Institute

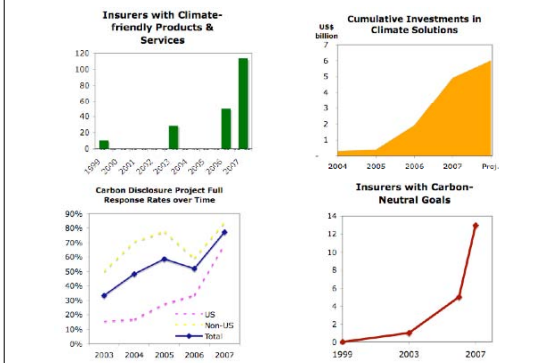
More Business!



Wide Range of Activities



Trends

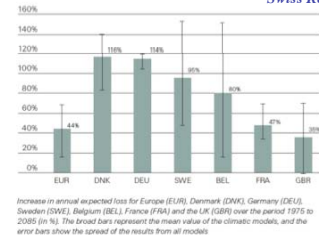


Understanding the Climate Change Problem: modeling

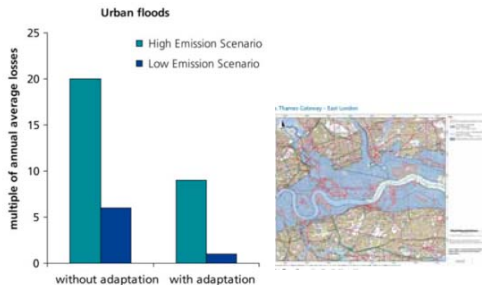
Efforts underway:

- AIG
- Lloyds
- Munich Re
- Swiss Re
- Willis
- RMS

Expected increase in annual windstorm loss in Europe
Swiss Re



Understanding the Climate Change Problem: land-use pln'g



Source: Modeling results for London. Adapted from Association of British Insurers, "Financial Risks of Climate Change, c. 2080s"

Promoting Loss Prevention: Building Codes

- Institute for Business and Home Safety's** "Fortified... for safer living" stds.

- Wind-resistant rigid foam panel walls and multi-glazed windows
- Ice-dam resistant
- Mold resistant
- Water-resistant insulation



BASF Home - Patterson NJ

Some insurers are giving premium credits...
why not combine with utility rebates??

Promoting Loss Prevention: Wetlands Restoration

- Tokio Marine & Nichido** has reforested 7,500 acres of mangroves in Indonesia, Thailand, Philippines, Myanmar and Vietnam. 5,000 more acres in progress



Source: <http://www.tokiomarine-nichido.co.jp/english/index.html>

Innovative Products

- Fireman's Fund:** first-ever "Green-Buildings Insurance"
 - 5% premium credits for green features
 - Rebuild green after loss
- Lloyds of London (Naturesave):** personal lines; commercial lines
 - 10 percent of premiums donated to environmental projects
 - environmental performance surveys offered to policyholders



Innovative Products

- Lockton Risk Services:**

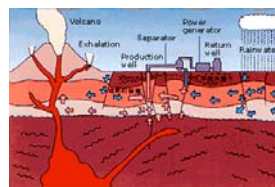
- group liability coverage for home energy auditors, if members of RESNET



Source: <http://www.locktonaffinity.com/RESNET/>

Innovative Products

- Energy Performance Insurance**
 - **Lloyds (and others):** Energy Savings Insurance
 - **Munich Re:** Geothermal exploration risk insurance

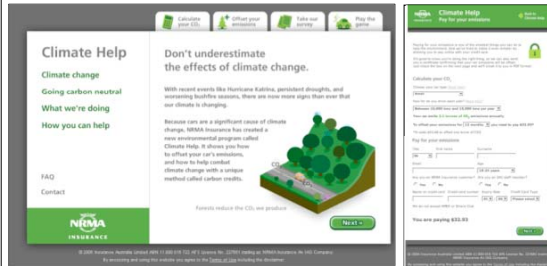


Legend
 — flow of cold water
 — flow of hot water



Innovative Products

- **Insurance Australia Group** offering on-line automobile carbon-offset service for customers



Source: <http://www.climatehelp.com.au/>

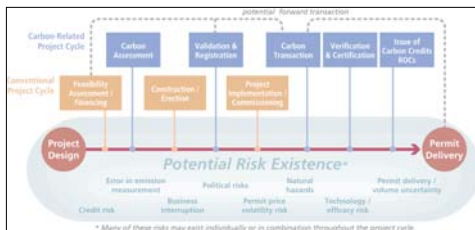
Innovative Products

- **Allianz, AXA, Cooperative:** Carbon-neutral car and travel insurance



Carbon Offset and Risk-Management Services

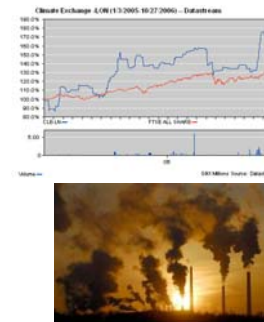
- **AIG, Marsh,** others offering carbon project risk-management consulting services; insurance



Source: Marsh. 2004. "Responding to Climate Change Risks and Opportunities."

Carbon Trading and Risk-Management Services

- **Swiss Re:**
 - Contingent-Cap Forward for Emissions Reduction Trades (cost risk hedge)
 - Carbon credit price volatility product
 - Carbon-delivery insurance



Aligning Terms & Conditions with Risk-reducing Behavior

- Insurance discounts of up to 40% for low mileage:

- **GMAC** 10k policies in Europe as of 2007.
- **Progressive** \$700M revenues projected by 2010
- **Norwich Union**
- **Polis Direct**
- **Rheinland**
- **Versicherungen**
- **Aioi**
- **Axa**
- **Pay-per-K**
- **Hollard**
- **Gerling**
- **Unigard**



General Motors Acceptance Corporation (GMAC) PAYD discount schedule.

Miles/year	Discount offered
1 – 2,500 miles	40%
2,501 – 5,000	33%
5,001 – 7,500	28%
7,501 – 10,000	20%
10,001 – 12,500	11%
12,501 – 15,000	5%
15,001 – 99,999	0%

Some use GPS --> stolen-vehicle recovery; avoids reporting fraud

Investment in Solutions

- **AIG Atlantic Station**
 - brownfields redevelopment
 - 8 million square feet LEED registered



Building Awareness & Formulation of Public Policy



Additional signatories as of 17 Sept 2007: ACE, Amlin, ARK, Beazley, BIBA, Chaucer, Diagonal Underwriting, Equity Group, Hardy's Underwriting, Hiscox, Legal & General, Marketform, Navigators, NFU Mutual, Prudential, QBE European Operations, RJ Kin, RMS, Standard Life, UNUM, XL

Source: <http://www.climatewise.org.uk/>

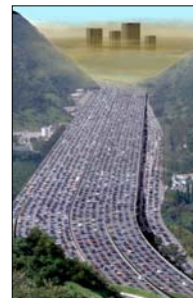
Announced Sept 17, 2007. 38 insurers and trade allies:

"We will lead the way in:

- Analysing and reducing risks;
- Support climate awareness amongst our customers;
- Incorporate climate change into our investment strategies;
- Inform and engage in public policy debate;
- And reduce the environmental impact of our businesses."

Building Awareness & Formulation of Public Policy

- **American Insurance Association** - Endorsing public transportation; reduced speed limits; telecommuting based on win-win benefits to insurers
- **Association of British Insurers** advising City of London on land-use planning and flood defenses

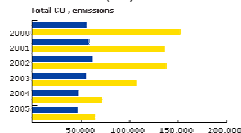


Leading by Example



Swiss Re's "Gherkin" building (London)

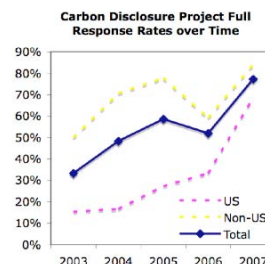
- **Carbon Neutrality**
 - **Rutherford** (US)
 - **Munich Re** (DE)
 - **Insurance Australia Group** (AU)
 - **Folksam** (SE)
 - **Aviva** (UK)
 - **Royal Sun Alliance** (UK)
 - **FP Marine** (HK)



Swiss Re: reduced emissions 2/3 between 2000 and 2005; purchased offsets for balance

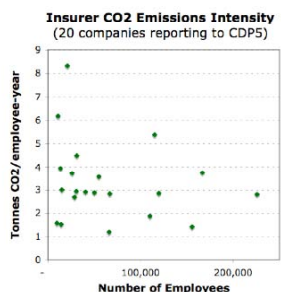
Carbon Risk Disclosure

Insurers responding to global survey (\$41 T under management):
AIG, Aon, Marsh & McLennan, MBIA, Safeco, St. Paul Travelers, Unum Provident, Munich Re, others...



Source: <http://www.cdproject.net/>

Insurer Emissions Vary by 7x!



Median value is greater than global per-capita emissions from transportation or housing....

Risks Are Also Associated with Responses to Climate Change



- Emissions reductions: supply- and demand-side
 - Green buildings
 - Nuclear power
 - Hydrogen energy
 - Renewable energy
 - Carbon capture & storage
 - Carbon offsets/trading
- Comparative risk assessments needed

Carbon Capture & Storage (CCS)

- Lake Nyos - 1986 (Cameroon): Natural CO₂ leak killed 1800 people, 3500 farm animals



Win-Win Solutions

- *Arkwright Mutual (now part of FM Global):* replaced fire-hazardous halogen "torchieres" with compact fluorescent alternatives at Northeastern University student housing + seminars for risk managers



Roles for Regulators (1 of 2)

- Follow the **science**.
- Motivate insurers to collect more/better **data**.
- Raise the standards of practice for catastrophe **modeling**; open-source model.
- Obtain better **disclosure** of climate risks.
- Promote climate-friendly **products and services**.
- Enable **actuarial pricing** with sensitivity to affordability.

Roles for Regulators (2 of 2)

- Focus on improved **building codes** and beyond
- Promote partnerships with policyholders for **loss mitigation**, e.g. financing upgrades.
- Safeguard surplus by encouraging prudent **investments**.
- Encourage insurers to minimize their **carbon footprint**.
- Communicate industry priorities to **governments**.
- Ensure **validity and quality of insurer climate initiatives, claims**.

Thank You



<http://insurance.lbl.gov>

Thank You



<http://insurance.lbl.gov>

Aligning Terms & Conditions with Risk-reducing Behavior

- **Travelers** offers 10% premium discount to drivers of hybrids
- **Swiss Re** - seeking D&O disclosure from insureds



Investment in Solutions

- **Swiss Re**: \$xxx million venture fund
- **Gerling**: Sustainable Development Project operates a \$100 million initiative including venture capital
- **Allianz**: has invested 10 million euros in the European Carbon Fund; plans to increase investments in renewable energy by 300 to 500 million euros will invest between \$350 and \$600 million in renewable energy

Building Awareness & Formulation of Public Policy

- **Swiss Re** has run full-page adds on climate change in major insurance trade journals for several years



Fingerprints.... Storms

- Climate change is affecting storm tracks, winds and temperature patterns
- Human-induced forcing has likely contributed



Source: IPCC 4th Assessment (2007)

Summary: Reasons for Concern

- Actuarial - losses in all lines (core business)
 - increased variability
 - unexpected correlation
 - affordability/availability
 - potential for abrupt change
 - CAT model deficiencies
 - difficult to function post-loss
 - data “blindspots”
- Contraction
- Competitive risk
- Regulatory risk
- Reputation risk
- Own Liability
- Assets & share prices are weather-sensitive; Ratings
- Macroeconomic downturn